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Report of the
Defense Science Board Summer Study Group on

FUNDAMENTAL RESEARCH IN UNIVERSITIES

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October 1976

Office of the Director of Defense Research and Engineering

Washington, D.C. 20301

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Report of the

Defense Science Board Summer Study Group on

FUNDAMENTAL RESEARCH IN UNIVERSITIES

(9) Final Summary
Sept. 1976

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Office of the Director of Defense Research and Engineering
Washington, D.C. 20301

(10) Ivan L. Bennett,
Harold W. Lewis,
Hans M. Mark,
Calvin F. Quate
George Gamota

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OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

5 November 1976

MEMORANDUM TO THE SECRETARY OF DEFENSE

THROUGH: THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

The attached summary report of the Defense Science Board Task Force on Fundamental Research in Universities was prepared at the request of the Director of Defense Research and Engineering. The Task Force, under the chairmanship of Dr. Ivan L. Bennett, Jr., consisted of members with wide scientific backgrounds and present responsibilities. A recommended general implementation plan has also been developed by Dr. Bennett and his group and is included in the report.

The Task Force points out that a major, potential source of innovative ideas for future defense needs resides in universities. Accordingly, there is need for the Department of Defense to reestablish and stimulate its relationship with the university science community.

It is fitting and timely that DoD has undertaken this study. It is noteworthy that the concerns and recommendations are very similar to those described in a recent report by the National Science Board titled "Science at the Bicentennial."

This report has been approved by the Defense Science Board, and I recommend it to you for your consideration.

A handwritten signature in black ink, appearing to read "Solomon J. Buchsbaum".

Solomon J. Buchsbaum
Chairman
Defense Science Board



OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D.C. 20301

5 November 1976

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Final Summary Report of the DSB Task Force on Fundamental
Research in Universities

I am pleased to submit to you the final report of the Task Force on Fundamental Research in Universities. This study was initiated at the request of the Director of Defense Research and Engineering. This report is based on studies commenced in May 1976 and mostly completed during the Defense Science Board 1976 Summer Study. It reflects comments and suggestions from many people within the Department of Defense as well as the academic community.

It is recognized that a major source for new innovative ideas for future defense needs resides in our university community. As a consequence, our report stresses the need for the Department of Defense to explore ways to re-establish and stimulate its relationship with the university science community.

In our summary report we make firm recommendations on how we can achieve the above stated goal and maximally ensure that we are also cost effective.

I would like to thank everyone for the cooperative spirit that the Task Force has received from all those involved in producing this report, in particular, the Military Services and their respective Offices of Scientific Research.

Ivan L. Bennett
Ivan L. Bennett
Chairman, DSB Task Force on
Fundamental Research in Universities

MEMBERSHIP

DSB Summer Study Group on Fundamental Research in Universities

Dr. Ivan L. Bennett, Chairman

Dr. Harold W. Lewis

Dr. Hans M. Mark

Dr. Calvin F. Quate

Dr. George Gamota, Executive Secretary

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I. INTRODUCTION

A. Objective

The main purpose of creating this summer study group was to explore ways to rekindle and stimulate the interests of the university science community in problems of national defense.

B. Background

Concern over DoD-University relationships has been voiced to the Defense Science Board (DSB) by representatives of academia (e.g., Frederick Seitz and Jerome Wiesner) and by the Director of Defense Research and Engineering (DDR&E). DSB volunteered to try to help solve the problem which, to oversimplify, arose through academia's disenchantment with and opposition to involvement in Vietnam and was aggravated by the Mansfield amendment and the subsequent emphasis on research "relevance."

The exit from Vietnam, the continuing difficulties of securing research funding in universities, the expressions of renewed interest in extramural and long-range research by DDR&E, and the probability of secular increase in 6.1 appropriations make it appropriate to look at the situation anew.

The Presidential Science and Technology Advisory Groups chaired by Drs. William Baker and Simon Ramo have appointed a committee to review federal support of basic research with particular emphasis upon support by the mission agencies with a view to making a recommendation to the new Presidential Science Advisor and Office of Science and Technology Policy (OSTP). Drs. Solomon Buchsbaum and Ivan Bennett serve on this committee along with Drs. Charles Slichter, chairman, and William Baker and Frank Press. The results of this DSB summer study and any follow-up could be coordinated eventually with the broader study effort contemplated for OSTP.

C. Reasons for Broadening and Strengthening DoD-University Relationships

It is generally agreed that the factors that have led to a diminution of interest of academic scientists in DoD-related problems have also gradually tilted emphasis in DoD research away from fundamental,

long-range science toward more applied, shorter-term, relevant subjects and projects.

In addition, the constituency of first-rate fundamental scientists, including younger investigators, willing and able to advise DoD, has diminished or, at least, has not been expanding in recent years. A main linkage to such scientific advice, in the past, has been support of fundamental research. From among scientists receiving support, there are those whose innovative ideas, analytic skills, and interest in thinking ahead to practical applications (and whose value to DoD then) go beyond their immediate and personal research activities or scientific disciplines.

We believe that the need to counter these trends furnishes important reasons for rejuvenating the DoD-University relationship.

1. The major (although not exclusive) strength of U.S. fundamental science resides in the universities. A re-engagement of this strength will be needed to assure a fundamental, long-range component in DoD research so as to balance the present emphasis on shorter-range, applied science.

2. In addition to support of research in fields where the subject matter is of obvious importance to presently defined problems of defense, the research strategy should include support for work in fields that seem less relevant or more remote in the short term including:

a. Fields where it is important that DoD establish and maintain a "window" into scientific progress.

b. Fields of interest primarily because of the superlative scientific competence of the individuals engaged therein.

D. Exclusions

1. This presentation contains no repetition of the differences between fundamental (basic) and applied research and no reiteration of the relationships among research, development, technological innovation, etc.

If and when it becomes desirable or necessary to recapitulate the many analyses, reports, and writings that have been generated on these subjects, we are prepared to do so.

2. Our deliberate focus, in this study, has been on DoD support for research in universities. We are aware that there are other federal sources of support and that scientists outside academic institutions can and do perform meritorious fundamental research. The work of these scientists is of importance to DoD. We believe that our recommendations, while oriented toward university scientists, are applicable to and will be welcomed by non-academic performers.

3. We have not looked specifically at problems of support or creation of incentives to perform fundamental research in industry or to stimulate industry to support research in academic institutions. We believe that these issues should eventually be dealt with in a DoD context. This aspect of research support, incidentally, is contemplated as an important component of the Slichter committee study for OSTP and, in many ways, can be better dealt with in a context broader than DoD alone.

4. We have been briefed (incompletely) concerning present policies, mechanisms, and problems of support of research, especially research in universities, by the Office of Scientific Research in each of the three Services (OXRs). We have not inquired directly about support by the Defense Advanced Research Projects Agency (DARPA) of fundamental research in universities. The OXRs are clearly asymmetrical. There are obvious merits and demerits arising from history, from battles for Congressional support, from the intramural-extramural performance philosophies of each Service, from differing concepts of quality control, from uncoordinated differential responses to the "relevance" problem, and from problems of quality and quantity of research management manpower. This last is a problem that seems increasingly serious in all of the Services and must be considered in any recommendations for change in the future. We are not prepared to make credible recommendations for changes in the OXRs or DARPA but we believe that the situation deserves thorough study and consideration in the near future.

II. OBSERVATIONS AND CONCLUSIONS

A. Major Questions Addressed

Since historically and, we believe, in the future, a principal basis for DoD-University relationships is support of fundamental research and since, clearly, any new initiative in this area by DoD should create a "two-way street," we have concentrated upon the following questions:

1. What are the obstacles, major and minor, to mutually beneficial DoD-University relationships?
2. How can the quality and long-range character of DoD sponsored research be improved and maintained?
3. How can the competence of scientists, including younger investigators, whose research is supported by DoD best be assured?
4. Through what mechanisms can DoD support be made more attractive to university scientists and to their institutions?
5. How can problems of "relevance" (Mansfield syndrome) be better dealt with or, at least, how can they be managed so as to interfere minimally with DoD-University relationships?
6. How can recommended changes or new initiatives be implemented rapidly and with maximum credible visibility?

B. Major Assumptions or Conclusions

Our recommendations and alternatives are based upon the following criteria:

1. Any action recommended should be one that can be implemented expeditiously.
2. Any action recommended should be attractive to the university, to the university community and the DoD.
3. Any action recommended should be highly visible and credible among academic scientists.

4. Any action recommended should be capable of eliciting positive and useful program initiatives from the university community.

5. Any increases in DoD funding for fundamental research should be accompanied by measures to:

a. Assure high quality of research.

b. Assure high caliber of investigators.

6. If truly new initiatives in support of fundamental research in universities are to be undertaken and are to succeed in the near future, it will be necessary to use a format other than a simple expansion of existing OXR and ARPA programs.

For the OXRs to serve as the conduits for funding a new program of university-based fundamental science will require the formulation, promulgation, and enforcement of uniform, new guidelines as a first step in a phased, longer-term reform of existing practices. This conclusion concerning the OXRs is not simply gratuitous. In response to a request for information from the three Services (Attachment #1) concerning DoD-University relationships, all declared the absence of any perceived problems and none suggested any measure to improve existing relationships since they are alleged to be at an all-time high since Vietnam.

C. A Cautionary Note

We have not, in any systematic way, assessed the potential response of academic scientists and universities to a new initiative (along the lines we recommend in the next section) by DoD in support of fundamental long-range support. We have anecdotal evidence from scientists in several institutions concerning the desirable characteristics of a new program. We have deliberately refrained from any wide-ranging inquiry for fear of the damaging effects of raising false hopes. We believe strongly that before any such assessment is made or any "feelers" are sent out to the academic science community, there should be a definite decision on a program, there should be assurance that substantial funding will be available for it, and once it is announced, it should be implemented promptly. Rightly or wrongly, academic scientists will react negatively to a hint at a new program and additional funding from any federal agency if it is not carried through expeditiously and at a substantial level. Therefore,

before any announcement of even the possibility of such a new program is broadcast among the academic science community, there should be substantial plans to go ahead, even though some of the detailed guidelines for the program remain to be worked out. The negative reaction to a false start will be difficult to counteract, no matter how powerful and compelling are the political reasons for failure to follow through. The political obstacles should be overcome before any publicity is given to a new departure that involves support of fundamental research in universities.

III. RECOMMENDATIONS

These fall into five categories: overall level of funding; issues of relevance; range of support by field and discipline; specific mechanisms of management, selection, and funding; and issues which require further study and analysis.

A. Overall Funding Level

The availability of new money will greatly facilitate any DoD initiative in fundamental science.

- It will facilitate program innovation without forcing the OXRs to modify and curtail existing commitments and to reallocate funds abruptly.
- "New money," especially phased, annual increases, will send up an important signal for the universities by establishing both visibility and credibility.

We have recently been made aware of current discussions within ODDR&E of a possible new program with substantial funding for support of fundamental research in universities. We applaud this action and are greatly encouraged by it. To assess various strategies and mechanisms, to obtain support of the OXRs, to minimize opposition by the Services and to obtain approval for additional funding from Congress are all proper functions of ODDR&E as are final decisions on such matters. Our recommendations, we hope, will be considered in this process.

- We recommend that DDR&E take advantage of the favorable climate for fundamental research and seek to secure phased "new funding," up to an annual program level of \$100,000,000 during coming budget cycles.

Attachments 2, 3 and 4 help put such a level of funding in perspective.

Attachment 2 shows trends ('74, '75, '76) in funding of basic research by federal agencies.

Attachment 3 shows trends in funding by performer; the flattening of University funding between 1975 and 1976 is apparent, making this a propitious time for a DoD initiative in this area.

Attachment 4 compares DoD and National Science Foundation (NSF) funding of basic research. It is apparent that a phased new program reaching \$100 million per year would double DoD's present level of commitment in these institutions.

B. Relevance

We recognize the political importance of the relevance of research to DoD problems in satisfying the public as well as Congress during the appropriations process. When the original Mansfield amendment mandated that all research supported by DoD be relevant to some military problem, the response of DoD (oversimplified) was to define all research being done under DoD auspices as relevant. This places two burdens upon research scientists and, despite changes in the legislative wording to permit the Secretary of Defense to determine potential relevance, etc., the actual practices in DoD have been a source of continuing annoyance, embarrassment, and irritation. First, applicants for support have to (or think they have to) think up reasons that make their projects relevant to a specific DoD mission. This is true despite the fact that DoD research management is supposed to do this through the mechanism of Form 1498. The contents of many 1498s ties a project so specifically to some weapon system or is otherwise so outrageously exaggerated that many investigators prefer (in self-defense) to generate their own rationales. Second, a university scientist was open to criticism from academic colleagues and students (scientists or non-scientists) if he was receiving DoD support even if his research was self-initiated and fundamental since, by definition, it was militarily relevant. The continuing overkill by DoD managers on this problem has led to the trend toward short-term applied research as a predominant component of DoD research programs and has posed a continuing problem for academic fundamental scientists. In any new program, we believe that these burdens on the scientist must be removed or minimized.

- We recommend that DoD continue to emphasize the importance and relevance of supporting fundamental research.
- We recommend that DoD not demand that a scientist demonstrate that his research project or program is relevant.
- We recommend that the issue of research relevance be raised from the individual project or program level to one of the relevance of a field of discipline.

--We recommend that DoD continue (at the level of fields and disciplines) to demonstrate to Congress, OMB, and the public that fundamental research is relevant to DoD missions, utilizing well-documented historical examples, etc.

What is of utmost importance is that relevance should be, in actual practice, the burden of DoD managers and not the research scientist and that relevance be judged and defended on the basis of field or discipline rather than project by project.

C. Range of Support by Field and Discipline

Most of what we have to say on this subject consists of assertions which we will translate into recommendations by saying:

--We recommend that policies concerning fields and disciplines be developed within the following guidelines and principles:

1. Decisions regarding the division of funding among various disciplines and fields are legitimately reserved to the Service research managers and ODDR&E.
2. These decisions should be made by taking into consideration recommendations of advisory committees from the involved scientific community.
3. In addition, disciplinary funding decisions should be coordinated with programs in other government agencies supporting basic research.
4. Once a policy for allocation of funds among scientific disciplines and fields of research has been established, proposals that are received should be judged on the basis of quality. As far as is politically possible, considerations of geographic distribution, etc. should be minimized.

--We recommend that review and selection of proposals for research be carried out utilizing some form of peer review mechanism, that this mechanism be developed by and for the Service OXRs, and that the nature of the mechanism be explained to academic scientists.

Generally, we are not in favor of an elaborate review mechanism (such as that at the National Institutes of Health (NIH)). We believe that peer review should be carried out in ways that will minimize delay in response to applications for support.

One of the greatest annoyances to academic (and all other) scientists seeking research support is the lag between submission of a proposal and final approval and funding. DoD's record in this regard is excellent and many investigators prefer to deal with DoD because of promptness of response. This advantage should not be lost in implementing peer review procedures.

This recommendation is not intended to preclude guidelines that would allow research managers to make funding available without complete peer review up to a certain amount per proposal or a certain percentage of available funds. Neither is it the intent to bar other internal rules such as a mandate that a given percentage of funds each year should go to new applicants, etc., etc.

D. Specific Mechanisms of Management and Funding

The importance of "new money" has already been alluded to. We have considered alternatives for administering a new program or programs of support for university-based fundamental science. In addition, we have identified certain changes in existing management practices which would enhance the attractiveness to academic and other scientists of DoD as a source of research support.

1. New funds might be administered directly from within ODDR&E. We examined this possibility as a temporary, transitional measure. Consideration of the difficulties of obtaining authorization and implementing such a departure from present procedures as well as the potential disruptive effects of by-passing the Service OXRs quickly cooled our initial enthusiasm. We mention it only for completeness.

2. New money could be allocated to OXRs or another DoD agency with uniform, specific, and enforceable guidelines for its use in a coordinated program of support for fundamental research in academic institutions.

3. Visibility and attractiveness of a new program could be achieved by using several procedures and policies: The following examples, for which detailed guidelines would have to be worked out, are not mutually exclusive and all should be seriously considered:

a. Large departmental or multidepartmental contracts (\$1,000,000+ per year) with procedures and safeguards appropriate to each institution to assure quality and accountability. It is likely that

different administrative patterns would prevail among the various universities.

b. Funding of the research of (20?) selected academic scientists for 5 years at a level of \$200,000 to \$250,000 per year. These contracts or grants could be made distinctive by a title such as "Awards for Fundamental Science."

c. Allocation of funds for new proposals (in annual amounts appropriate to a given discipline) received from non-tenured (younger) faculty members or faculty members not previously supported by DoD funding. This would be a mechanism for solving an important problem in the universities and, in addition, would help to "recruit" a new constituency for DoD.

d. Some form of "institutional general research grant," the amount to be determined by a formula based upon DoD grant and contract funding at an institution. This would be conditional upon the existence of an agreed administrative procedure, appropriate to each institution for allocating the funds in accordance with DoD guidelines and policies (similar to the General Research Support Programs of NIH).

e. Modify present arrangements for DoD payment of overhead on grants and contracts to one in which the scientist neither computes the overhead nor is penalized by changing institutional overhead rates in subsequent years (similar to NIH). This would mean that the scientist could count on a definite amount for direct costs of research from year to year no matter when changes in institutional indirect costs might occur. This change would have enormous appeal among university investigators.

f. Develop guidelines and policies for allocating funds that will give high priority to new equipment and instrumentation including realistic provisions for operation, maintenance, and repair, a "total cost" approach. There has been a serious lag in availability of research equipment in recent years because of restricted funding as well as GAO efforts to introduce "efficiency" into equipment utilization in research laboratories, leading to bureaucratic timidity on the part of federal research managers. A new, enlightened policy giving priority to equipment needs would attract wide attention as a new departure among academic scientists.

g. Push for rapid implementation of the declared policy to establish the ratio of intramural to extramural research at 30:70.

Within the DoD there is a common source of funding for in-house research and the extramural programs. We are aware of the current plans for implementing the policy of funding these programs with 30% for the in-house laboratories and 70% for the extramural programs and applaud DDR&E for taking this position. However, we want to call attention here to the situation that comes about when the Congressional appropriations are below the requested level. The cuts are now taken largely from the extramural programs and make it difficult to reach the desired 30-70% goal. Furthermore, it results in strong variations in the funding of local areas within the University. This should be corrected as soon as possible for it is now detrimental to our plan for strengthening the DoD-University programs in science and engineering. Attachment 5 shows the estimated distribution of effort for basic and applied research programs of the Services for 1976.

E. Issues for Further Study and Analysis

We believe that other issues need to be addressed and that the advice of involved scientists will be helpful in this process.

1. Assessment of the potential response of universities and academic scientists to a new initiative by DoD in support of fundamental long-range research along the lines described in this report. This should be undertaken only after a definite general decision to go ahead with a program has been made.
2. Improvement of research management structure and procedures at the Service and DDR&E level.
3. Choice of scientific fields and disciplines of "relevance" to DoD missions and objectives including priorities and opportunities for allocation of funding.
4. Consideration of funding research in fields of interest because of scientific competence of individuals in the field or need to keep abreast of scientific progress in areas that now seem more remote from DoD problems.
5. Advisory focus for DoD in any government-wide assessment of support of research by mission agencies such as that now contemplated by the Slichter Panel for OSTP.

6. Development of a firm rationale for DoD support of research--convincing to public, Services, Congress, and the scientific community.

Attachment #1



OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C. 20301

13 May 1976

MEMORANDUM FOR Assistant Secretaries of the Military Departments
(Research and Development)

SUBJECT: Defense Science Board Summer Study/Research

The Defense Science Board will cover Research as one of four topics in its 1976 Summer Study (DDR&E letter attached). The panel will be chaired by Dr. Ivan Bennett and the Executive Secretary is Dr. George Gamota from my office.

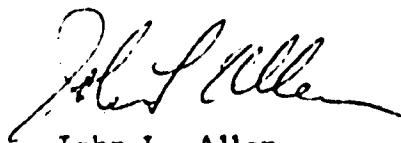
Dr. Bennett wishes the panel to address the question of "How can the DoD Revive and Stimulate the Interest of the Academic Community in DoD Research Problems?" He has asked that we provide representatives from each Service to attend a special DSB meeting on May 27 and be prepared to provide the following information:

- 1) Describe the scope of their current university research program.
- 2) Provide a review of the mechanics of contract research or grants.
- 3) Describe the current relationship with the academic community--citing examples whenever possible of current interactions, particularly contacts of in-house laboratories with academic centers.
- 4) Cite specific suggestions of how the current relationship with the academic community can be improved.
- 5) List problems the Services are experiencing in attempting to give research funds to universities.
- 6) Discuss specifics of how the Mansfield Amendment influences DoD research and the interaction with academic centers.



It should be emphasized that all DSB panel members are vaguely familiar with the DoD research program and little discussion should take place regarding the content of the research being performed by the universities.

I have arranged the special DSB meeting on Research to be held in the Pentagon in Room 2E 271 on May 27, 1976. The Service representatives should contact Dr. Gamota, x73749, to coordinate the program by 21 May 1976.



John L. Allen
Deputy Director
(Research and Advanced Technology)

Attachment #2

FEDERAL OBLIGATIONS FOR BASIC RESEARCH, BY AGENCY
(Dollars in Millions)

Agency	Actual		Estimates		Percent Change 1974-75	Percent Change 1975-76
	1974	1975	1975	1976		
Total	\$2,465	\$2,596	+4.8	\$2,689	+3.6	
NASA	733	698	-4.8	737	+5.7	
NSF	415	476	+14.7	538	+12.9	
HEW	561	560	-.2	485	-13.3	
ERDA	232	261	+12.1	292	+12.0	
DOD	244	245	+.4	259	+5.8	
Other	280	356	+27.7	378	+6.0	

Attachment #3

FEDERAL OBLIGATIONS FOR BASIC RESEARCH, BY PERFORMER
(Millions of Dollars)

Performer	Actual		Estimates		Percent Change 1974-75	Percent Change 1976 1975-76
	1974	1975				
Total	\$2,465	\$2,596	+5.3	\$2,689	-	+3.6
Federal Intramural	661	736	+11.4	766	-	+4.1
Industrial Firms	495	487	-1.7	534	-	+9.6
Universities and Colleges	970	1,025	+5.7	1,026	-	+.1
FFRDCs Administered by Universities	200	219	+9.3	247	-	+13.2
Other Non-profit Institutions	108	100	-7.7	88	-	-12.0
Other Performers	31	31	-2.0	29	-	-5.1

Attachment #4

SUPPORT OF FUNDAMENTAL RESEARCH:^a
(Estimated FY 1976)
(Millions of Dollars)

	Total	University (%)
Department of Defense	259	99 (38%)
Army	48	6.5 (14%)
Navy	120	62.5 (52%)
Air Force	84	25 (30%)
Defense Agencies	36	15 (40%)
National Science Foundation	538	447 (83%)

*Source: NSF 75-334

Attachment #5

DoD SUPPORT OF RESEARCH BY PERFORMERS*

	Fundamental			Applied		
	Intramural	Industry	University	Intramural	Industry	University
DOD, Total	44%	14%	38%	42%	47%	--
Army	72%	10%	14%	70%	21%	--
Navy	36%	10%	52%	70%	17%	--
Air Force	55%	14%	30%	28%	64%	--
Defense Agencies	11%	28%	40%	28%	52%	--

*Source: NSF 75-334